

THAT WHICH IS CLAIMED:

1. An optical tube assembly comprising:

a tube;

at least one optical waveguide, the optical waveguide being
5 disposed in the tube; and

at least one dry insert, the at least one dry insert having
a first layer and a second layer, the first layer being a
polyurethane foam and the second layer being a water-swellable
layer, wherein the dry insert is disposed within the tube and
10 generally surrounds the at least one optical waveguide.

2. The optical tube assembly of claim 1, the at least one dry
insert being compressed at least 10 percent or more for coupling
the at least one optical waveguide to an interior surface of the
15 tube.

3. The optical tube assembly of claim 1, the compression of the
foam tape being about 90% or less for coupling the at least one
optical waveguide to the interior surface of the tube.

4. The optical tube assembly of claim 1, the polyurethane foam
being an open cell ether-based polyurethane foam.

5. The optical tube assembly of claim 1, the water-swellable
25 layer being a water-swellable tape.

6. The optical tube assembly of claim 5, the water-swellable
tape having a first water-swellable component and a second water-
swellable component.

7. The optical tube assembly of claim 1, further comprising one
or more materials selected from the group of adhesives, glues,
elastomers, and polymers for attaching the at least one dry
insert to the tube.

8. The optical tube assembly of claim 1, the at least one optical waveguide being a portion of a fiber optic ribbon, the fiber optic ribbon having a positive excess ribbon length (ERL).

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9. The optical tube assembly of claim 1, the polyurethane foam having a density in the range of about 1 lb/ft³ to about 3 lb/ft³.

10 10. The optical tube assembly of claim 1, the at least one optical waveguide having a normalized ribbon pull-out force between about 0.5 N/m and about 5.0 N/m.

11. The optical tube assembly of claim 1, the at least one
15 optical waveguide having a normalized pull-out force between about 1 N/m and about 4 N/m.

12. The optical tube assembly of claim 1, the at least one optical waveguide being a portion of a ribbon, the ribbon having
20 a normalized ribbon pull-out force between about 0.5 N/m and about 5.0 N/m.

13. The optical tube assembly of claim 1, the at least one optical waveguide being a portion of a ribbon, the ribbon having
25 a normalized pull-out force between about 1 N/m and about 4 N/m.

14. The optical tube assembly of claim 1, the at least one dry insert having an uncompressed height h of about 5 mm or less.

30 15. The optical tube assembly of claim 1, the optical tube assembly being a portion of a fiber optic cable.

16. The optical tube assembly of claim 15, the fiber optic cable having a normalized ribbon coupling force between about 0.5 N/m and about 5 N/m.

5 17. The optical tube assembly of claim 1, the optical tube assembly being a portion of a fiber optic cable, the fiber optic cable having an armor tape.

10 18. The optical tube assembly of claim 1, the at least one optical waveguide being a portion of a ribbon stack having at least one corner optical waveguide, the at least corner optical waveguide having a MAC number of about 7.35 or less.

15 19. The optical tube assembly of claim 1, the tube being formed from a bimodal material.

20. The optical tube assembly of claim 1, the at least one optical fiber having an excess fiber length.

20 21. An optical tube assembly comprising:

a tube, the tube having an interior surface;

at least one optical waveguide, the at least one optical waveguide being disposed within the tube and having a positive excess length compared with the tube; and

25 at least one dry insert, the at least one dry insert having at least two laminated layers generally surrounding the at least one optical waveguide, thereby forming a core that is disposed within the tube, the at least one dry insert act to couple the at least one optical waveguide to the interior surface of the tube
30 while cushioning the at least one optical waveguide, thereby maintaining an optical attenuation below about 0.4 dB/km.

22. The optical tube assembly of claim 21, the two laminated layers comprising a compressible layer and at least one water-swella-
ble layer.

5 23. The optical tube assembly of claim 22, the compressible layer being a polyurethane foam tape that is compressed by about 10% or more.

24. The optical tube assembly of claim 22, the compressible
10 layer being a polyurethane foam tape that is compressed by about 90% or less.

25. The optical tube assembly of claim 21, one of the two laminated layers comprising an open cell ether-based polyurethane
15 foam.

26. The optical tube assembly of claim 21, one of the two laminated layers being a water-swella-
ble tape.

20 27. The optical tube assembly of claim 21, one of the two laminated layers being a water-swella-
ble layer having a first water-swella-
ble component and a second water-swella-
ble component.

28. The optical tube assembly of claim 21, further comprising
25 one or more materials selected from the group of adhesives, glues, elastomers, and polymers for attaching the at least one dry insert to the tube.

29. The optical tube assembly of claim 21, the at least one
30 optical waveguide having a normalized pull-out force between about 0.5 N/m and about 5.0 N/m.

30. The optical tube assembly of claim 21, the at least one optical waveguide having a normalized pull-out force between about 1 N/m and about 4 N/m.

5 31. The optical tube assembly of claim 21, the at least one optical waveguide being a portion of a ribbon, the ribbon having a normalized pull-out force between about 0.5 N/m and about 5.0 N/m.

10 32. The optical tube assembly of claim 21, the at least one optical waveguide being a portion of a ribbon, the ribbon having a normalized pull-out force between about 1 N/m and about 4 N/m.

15 33. The optical tube assembly of claim 21, the at least one dry insert having an uncompressed height of about 5 mm or less.

20 34. The optical tube assembly of claim 21, the at least one optical waveguide being a portion of a fiber optic ribbon, the fiber optic ribbon having a positive excess ribbon length (ERL).

35. The optical tube assembly of claim 21, the polyurethane foam having a density in the range of about 1 lb/ft³ to about 3 lb/ft³.

25 36. The optical tube assembly of claim 21, the optical tube assembly being a portion of a fiber optic cable.

30 37. The optical tube assembly of claim 34, the fiber optic cable having a normalized ribbon coupling force between about 0.5 N/m and about 5 N/m.

38. The optical tube assembly of claim 21, the optical tube assembly being a portion of a fiber optic cable, the fiber optic cable having an armor tape.

39. The optical tube assembly of claim 21, the at least one optical waveguide being a portion of a ribbon stack having at least one corner optical waveguide, the at least corner optical waveguide having a MAC number of about 7.35 or less.

40. The optical tube assembly of claim 21, the tube being formed from a bimodal material.

41. The optical tube assembly of claim 21, the at least one optical fiber having an excess fiber length.

42. An optical tube assembly comprising:
a tube;
at least one optical waveguide; and
at least one dry insert, the at least one dry insert having a polyurethane foam layer, wherein the at least one dry insert and the at least one optical waveguide form a core disposed within the tube, wherein the at least one optical waveguide has a normalized pull-out force between about 0.5 N/m and about 5.0 N/m.

43. The optical tube assembly of claim 42, the normalized pull-out force being between about 1 N/m and about 4 N/m.

44. The optical tube assembly of claim 42, the at least one optical waveguide being a portion of a ribbon, the ribbon having the normalized pull-out force.

45. The optical tube assembly of claim 44, the normalized pull-out force of the ribbon being between about 1 N/m and about 4 N/m.

46. The optical tube assembly of claim 42, the at least one dry insert comprising an open cell ether-based polyurethane foam layer and at least one water-swellaable layer.

5 47. The optical tube assembly of claim 46, the water-swellaable layer being a water-swellaable tape.

48. The optical tube assembly of claim 42, the polyurethane foam layer being compressed by about 10% or more.

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49. The optical tube assembly of claim 42, the polyurethane foam layer being compressed by about 90% or less.

50. The optical tube assembly of claim 42, the dry insert
15 further comprising a water-swellaable layer having a first water-swellaable component and a second water-swellaable component.

51. The optical tube assembly of claim 50, the first water-swellaable component being effective for ionized liquids and the
20 second water-swellaable component being effective for non-ionized liquids.

52. The optical tube assembly of claim 42, further comprising one or more materials selected from the group of adhesives,
25 glues, elastomers, and polymers for attaching the at least one dry insert to the tube.

53. The optical tube assembly of claim 42, the at least one dry insert having an uncompressed height of about 5 mm or less.

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54. The optical tube assembly of claim 42, the optical tube assembly being a portion of a fiber optic cable.

55. The optical tube assembly of claim 54, the fiber optic cable having a normalized ribbon coupling force between about 0.5 N/m and about 5 N/m.

5 56. The optical tube assembly of claim 42, the at least one optical waveguide being a portion of a fiber optic ribbon, the fiber optic ribbon having a positive excess ribbon length (ERL).

10 57. The optical tube assembly of claim 42, the polyurethane foam having a density in the range of about 1 lb/ft³ to about 3 lb/ft³.

15 58. The optical tube assembly of claim 42, the optical tube assembly being a portion of a fiber optic cable, the fiber optic cable having an armor tape.

20 59. The optical tube assembly of claim 42, the at least one optical waveguide being a portion of a ribbon stack having at least one corner optical waveguide, the at least corner optical waveguide having a MAC number of about 7.35 or less.

60. The optical tube assembly of claim 42, the tube being formed from a bimodal material.